NICOLAUS de Cusa [KHRYPFS or KREBS (NIKLAS)] 1401–64.

7602. In English, on paper: written in 1919 by D. D. K. Willis: $13\frac{1}{4} \times 8\frac{1}{8}$ in., vi+29 leaves.

'Nicolas de Cusa. De Staticis Experimentis'; a translation, made for Sir W. Osler by D. D. Kirkaldy Willis, of bk. 4 of the 'Idiota' from the undated ed. of the opuscula, nos. 7465–6 (see notes). With correspondence from the translator.

On fol. v Sir W. Osler has added suggestions as to the publication of the tract, its importance in the history of the scientific use of the balance, &c. They are addressed to Dr. Viets, who published this translation in 1922—see no. 3498.

'The Idiot, in 4 books', London, 1650, contains an early translation (Viets, no. 3498, p. 123).

iii

73 Welbeck St. London. W.1
31. 3. 1919.

Dear Sir,

Thank you for the De Cusa received this morning. Note you wish the wrapper & label returned, & I take this to mean with the Volume, when finished with. There are markers in several places in the book, but I understand "De staticis experimentis" is the passage required. If you would like me to insure the volume while in my care, kindly let me know its value.

Yrs Sincerely
D W Kirkaldy

Published 1922
in No. 3498.

From the Hackh,
- Hain 5893(1)

3) Ask that new Prof of the Hist. of Science at Harvard or Lady of Pittsburg. about the problems here discussed by C.

4 The Plant & Torrent — discuss & relation to von Helmholtz pamphlet & experiments & S. Hales.

5 Return this MS. to me. — no hurry

W Osler

POST CARD

TO BE USED FOR WRITTEN OR PRINTED MATTER

ONLY THE ADDRESS TO BE WRITTEN HERE

Sir William Osler, Bart.
13 Norham Gardens
Oxford.

iii

...mentos,

... Dr Viets

... made from the Hackl, w

... Ed. prin. – Hain 5893(1)

... life & times & library it

... print this, as it has never

appeared in English, with a note upon the growth

of the use of balance.

3) Ask that some Prof of the Hist. of Science at

Harvard or Univ of Pittsburg. about the problems

here discussed &c.

4 The Plant experiment – discuss the relation of

van Helmont's famous experiment & S. Hales.

5 Return this MS. to me. – no hurry

W Osler

Published 1922

in No. 3498.

owing to a decision to
move to a very fine
site in Regents Park.
In May, too, I was out of
town a good deal.

I should be glad if
you would kindly let
me know if the translation
is of any use & what you
will be doing with it.

Yours sincerely,
D D Kinkaldy Willis

Sir Wm Osler Bart.

iv

73, Welbeck Street, W.1.

July 14th 1919.

Dear Sir.

I returned "De Cusa" on Saturday & now send the translation of De Staticis Experimentis.

I am sorry to have been so long over it: but I was at first very busy at the Hospital & we are now in some confusion

Nicolas de Cusa –

De Staticis Experimentis.

To Dr Viets

1 This translation is made from the Hach[e], Strasburg edition – Ed. prin. – Hain 5893[11]

2) after an account of his life & times & library, it might be worth while to print this, as it has never appeared in English, with a note upon the growth of the use of the balance.

3) ask that some Prof of the Hist. of science at Harvard or Univ of Pittsburg. about the problems here discussed &c.

4 The Plant experiment – discuss the relation of van Helmont's famous experiment & S. Hales.

5 Return this MS. to me. – no hurry

W Osler

vi (ult.)

1/ The layman's treatise concerning experiments with scales begins pleasantly.

The well-known Roman priest used to keep company with the layman so that he might now & then hear his ideas, which pleased him.

When the priest praised a balance as being the scales of justice & an instrument of necessity to the state, the layman replied:-

Layman. Although nothing in this world can reach absolute precision, yet we endeavour to establish more accurate judgment & so it is accepted on all sides. But tell me, pray, since it is not possible for a weight to be of the same size in circumstances of diverse origin, should not each weight be tested by different experiments?

Priest. I have neither read nor heard so -

L. Such some one would furnish such a verification. Even were it spread over many volumes, I would gladly give attention to it.

P. If you felt inclined to do it, I do not think anyone would do it better.

L. Anyone who wished could do it, for it is quite easy: but I lack the time.

P. Just speak of its usefulness & system; I will see if I, or someone else can finish it.

2. L. I think the mysteries of things are more truly solved by the differences of their weights, and that a great deal might be ascertained by a more accurate interpretation.

P. What you say is really excellent. For thus the prophet tells what is the weight & balance, while the decision is His, who has created all things in number weight & measure, & has launched springs of water and weighed out the mass of the earth, as the wise man writes.

L. If therefore a measure of the water of one spring is not of the same weight as an equal measure of another, the decision as to the different nature of the one & the other is better attained by a scale than by any other instrument.

P. You say well. Vitruvius writing on architecture advises that a site for a house should be chosen, which has lighter & sharper waters, while one which has heavy & earthy waters should be shunned.

L. Thus the waters of the same spring seem to be of the same weight & nature; whilst those of different springs are of different weight.

P. You say they seem: as though they were really something else.

L I admit that weight varies with time — perhaps sometimes imperceptibly; for ~~the~~ undoubtedly the weight of water is at one time this & at another time that —

3. So too there is one weight of water round about a spring, another at a distance from the spring: but the differences being scarcely perceptible are considered of no consequence.

P. You think then that in everything, it is just as you have said in respect of water?

L. Certainly I think so. For by no means have things similar in size, yet different in quality, the same weight. Hence since there is difference in the weight of the blood & urine of a healthy man & of a weak one, of a young man & of an old, of a German & an African, would not a physician hold it of the greatest value to have all these differences registered?

P. Most certainly. Indeed through having the weights authenticated he would think himself in an admirable position.

L. Now I think a physician would be able to come to a truer decision from the weight of urine & from its colour at the same time, than from a deceptive colour.

P. Most certainly.

L. So also, as the roots, stems, leaves, fruits, seeds & sap of herbs have their own weight, if the weights of all herbs were registered with their various situations, a Physician could better arrive at the nature of them all from their weight & odour, than from a deceptive taste.

4/: P. You speak excellently.

L. He might then learn from comparing the weights of herbs with the weight of blood, or urine, to arrive at the amount to be applied from the similarity & difference of the drug, and to make wonderful prognoses, & so from experiments by the scale everything knowable could be reached by a more accurate inference.

P. It is greatly to be wondered at that hitherto so many hard working researchers have been inactive in registering weights.

L. Do you not think that if you let water flow from the rigid opening of a water clock into a basin for so long as you could feel the pulse of a healthy youth beat a hundred times, and did similarly in the case of a weak lad, that differences of weight betwixt the waters would fall under your notice?

P. Who doubts it?

L. From the weight of waters therefore, the differences of the pulses would be arrived at, in the young, old, healthy, infirm, & so a truer knowledge of the disease: since there necessarily turns out to be one weight in one infirmity, another in another. Wherefore a more accurate judgment might be arrived at by such a difference

5. resulting from an experiment of the pulses, & by the weight of the urine, than by the touching of a vein (? artery) & the colour of urine at the time.

P. You speak excellently.

L. If what has already been affirmed up to this point from the position of the weights of water affects spitting or breathing by inspiration & expiration, would it not still give a more accurate inference?

P. It would, certainly.

L. ~~For~~ If, while waters flowed from a clock, 100 expirations were counted in a boy, and similarly in an aged man, it is not possible that the waters should turn out to be of the same weight. So I say in respect of other diverse ages & constitutions. Then when a physician had definitely fixed the weight of the breath of a healthy boy or young man, and likewise of a man suffering from various weaknesses, undoubtedly by such an experiment he would arrive more surely at the knowledge of health & (a fall away from it, ~~[illegible]~~ & at the quantity of the remedies.

P. Yes even at inferences of their period.

L. You speak well - For if he were to discover in an uninjured youth the weight of an old &

6. decrepit man, he would infer that he was surely about to die, & he would make wonderful inferences of this kind. If still in the case of fevers he could register by a similar method the conditions, hot & cold, by the differences of the weights of the water, would he not be able more truly to arrive at the effectiveness of the disease & the fitness of the remedy?

P. Undoubtedly he could, for he would test the ascendency of one quality over another, of heat over cold, & conversely: & according to the condition he had found, he would apply certain measures.

L. Still I say in different nations, districts & types these conditions change at the same period of age, whence although difficult, it would be very useful to have them all registered according to their weights.

P. It is just as you say.

L. It seems, however, that the weight of each thing should be taken as the average of its weights, as they vary in different climates. As, for instance, if the weight of a man be considered in comparison with another animal; then the man should be considered, not as living in the North or South, where here or there he is beyond the average; but rather as living in an average climate.

7.

P. You speak excellently. The ancients called that climate "Dyarodon" for it stretched from East to West through the island of Rhodes. But I should like to know how you would proceed, if you were seeking the weight of an entire man, in comparison with any other animal.

L. I should place the man on a scale and should hang a weight equal to him on another part of it: then I should put the man into water, and again outside the water I should hang a weight, equal to him, from another part: and I should note the difference of the weights. Also I should do the same with the given animal, & I should note down what I had learned from the various differences of the weights. After this I should direct my attention to the difference of the weights of man & animal out of the water, and then adjust and write down what I had found.

P. I do not approve of this principle of adjusting.

L. I will show you, he said, and having taken a light piece of wood, whose weight was as III, while that of water filling the same space was as V, he divided it into two unequal parts, one of which was double the size of the other. He put both in a tall cask and held them down with a stick, while he poured water over them, & when he withdrew the stick, the pieces of wood jumped to the surface

8 of the water; and the larger piece quicker than the smaller. Look, he said, you see the difference of motion in exact proportion with its cause, for in light pieces of wood, there is more lightness in the larger one.

P. I see & I am greatly pleased.

L. So I say adjustment ought to be made. For, if a man became of his greater size was heavier than an animal, he would sink in water quicker than an animal of the same proportion. Wherefore then the adjustment of a difference that has been discovered ought to be made by proportionally diminishing its excess.

P. I understand now. But tell me how the water hinders the wood sinking.

L. Because the greater heaviness hinders the less. Wherefore if you have pressed a round piece of wood into wax & drawn it out, filling its place with water, and have noted the weight of this water and similarly of the wood, you will find that if the weight of the wood exceeds the weight of the water, the wood sinks: if not it floats, & a part of the wood remains above the water in proportion to the excess of the weight of the water over the weight of the wood.

P. Why do you talk of round wood?

L. If it is of a broad shape, it will cover more of the water & will float higher. Hence ships in waters of little depth ought to be of a wider bottom.

[illegible] does any other metal: A question has far

P. Can all precious stones be weighed in like manner?

Q. P. Go on with what you have begun. Could the weights of animals be arrived at in any other way?

L. I think they could. For if you filled a balance with water up to the brim and put the same into another: then took the weight of a man outside the water: after this made him sink in the former scale & collected & weighed the water that flowed out, proceeding in like manner with another man, or animal, or any other thing, from the differences of the weights by an acute calculation you would arrive at what you sought.

P. Plainly I have often heard, said the priest, that at times the difference of metals has been discovered by this system, & that some men have noted how much gold, silver, copper, & so of all metals, is collected by pouring out an ounce of wax.

L He who observes the quantity during its pouring out deserves to be praised. For he sees that if gold occupied as much space as an ounce of wax, then its weight would be so much. Thus too of other metals. For it is very certain that gold has one weight, silver another & other metals in ~~comparison with~~ relation to their quantity. And the weight of anything you like is one thing in air, another in water, another in oil, or in other liquid. Then, if anyone had all these weights registered, he would know forthwith how much heavier one metal is than another in air, or how much in water. Hence whatever mass were given, through the difference of its weights in air & water, he could tell to what metal, or to what mixture, the mass belonged, as it has been

does any other metal: A question has far

P. Can all precious stones be weighed in like manner?

10/ settled regarding air & water, so also it could be settled concerning oil, or any other fluid, in which an experiment has been made.

P. So without pouring out the mass, or separating the metals, the mixture would be found out, & this system would be useful in mints to find out how much copper has been mixed with gold or silver.

L. You say well. Certainly it would be of very great value in ascertaining how far the works of sophistical chemistry fall short of reality.

P. If anyone therefore proposed to write a book on weights he ought even to register the difference of every metal, as it seems; for the gold of Hungary has one weight, the gold of Obren another. And so of each metal.

L. From the foregoing statements it is certain that as in springs, so also in mines difference of weight is found. Gold, however, wherever it is found, is always heavier than any other metal. So that golden glitter is found to vary in weight within a certain limit — And so of the rest.

P. From the position of the weights of metals, can the position of their masses be sought for?

L. Lead is much like gold in weight, but not at all as regards its perfection. So, I do not consider that attention should be given to one weight alone, but to each weight in turn. For, if anyone gives attention to the molten fire both of ~~that~~ gold & lead, he will find that lead approaches gold less than any other metal: & if anyone gives attention to the weight of the fire of melting iron, he will realize that iron approaches gold more nearly than does any other metal: A question has far

P. Can all precious stones be weighed in like manner?

this is of less importance in comparison with gravity.
Wherefore all sorts of weights ought to be given attention – not gravity only, & thus we find silver to be nearer to gold.

P. Vitruvius says concerning the weight of the substance of gold that it alone sinks in quicksilver, of however little heaviness it may be, whilst other metals float of however great mass they are.

L. Quicksilver can be compared with all metals on account of the property common to itself & them; but it clings more closely to gold, as the least perfect in its quality to the most perfect. Hence those who have leisure for experimenting in chemistry seek to overcome quicksilver by fire, when not only does it not vanish from the fire; but keeps all other metals, to which it is united, fixed with itself and not only this; but brings them to the weight of gold by its permanent nature of flowing & its malleable moisture, and tinges them with a fixed & permanent colour.

P. Do you think then it is possible to accomplish what they propose?

L. Accuracy remains unattainable: but how far they have progressed the scale shews, without which they can accomplish nothing certain, for by this judgment of fire & scale, investigation of this subject can be made.

P. Can all precious stones be weighed in like manner?

12/L. There is no doubt that all can be weighed by one system, for a diamond has one weight as compared with a piece of lead of equal size, and a sapphire has another, likewise compared with a piece of lead of equal size, and from their different sizes the relation of the leaden weights of each is known – And similarly concerning all stones, so that by that method of experiments with a scale, it would be very useful to have the weights registered with their different sources, so that if any falsities were made in beryl or coloured crystal they could be detected.

P. As a stone has one weight in air, another in water & another in oil, it would be good to have their differences noted, so that without referring to lead or any other third matter, the differences of their weights might be known.

L. You speak excellently.

P. Tell me if it appears to you that the value of stones could be weighed by any other method.

L. I think that the value of a loadstone might be weighed, if iron having been placed on one side of a scale, and loadstone balancing it on the other side, then, the loadstone, weighing so much, having been taken away & another weight substituted for it, if the loadstone were held over the iron so that the iron fixed on the double sided balance were attracted upwards to the loadstone, by this movement out of level with the other side the weight would be made heavier until the iron was pulled back to the level, while the loadstone remained unmoved. I think, the value of the loadstone might be said to have been weighed (relatively) through this drawing back of the weight (to its former level position).

13/ Similarly also the value of a diamond ought be arrived at from how far it is said to prevent a loadstone from attracting iron, & other values of other stones from their control & also from the difference of the size of their substance, since in a larger substance would be larger value

P. Could not also a skilled man find out how much quicksilver & how much sulphur any metal, or stones, contain?

L. He could certainly by the agreement & disagreement of weights closely search out all such questions, & likewise the elements of quicksilver from the difference of its weight in air, water, & oil, compared with water & oil, & with the weight of ashes of the same size. So also of Sulphur. Thus through this method he could arrive by a more accurate inference at the elements of all metals & stones & at the weights of their elements.

P. These are admirable ideas. Could it not also be done in respects of herbs, woods, flesh, animals & fluids?

L. In respect of all I think. For when wood has been weighed, & after being burned its ashes weighed too, one ~~can~~ learns how much water was in the wood, for oil, water & earth have a heavy weight. Likewise it is known from the difference of the weight of wood in air, water, & oil, how much that water in wood is heavier or lighter than the pure water of a spring - So too, how much air (was in the wood) and ~~then~~ from the difference of the weights of the ashes how much fire, & thus ~~for~~ the elements are searched for by a more accurate inference; altho absolute precision may be always unattainable. ~~Also~~ what has been said concerning wood may likewise be said of herbs, flesh & other things.

4. P. It is said that no simple element can be found in the way in which we have done this experiment by scale.

L. If anyone having put 100 lbs. of earth in a cask, afterwards packed up the 100 lbs., excluding herbs, or seeds, which had been thrown upon the earth, after first being weighed; & in a short time again weighed that earth, he would find it diminished in weight. From which he would gain an opinion that the herbs he had gathered had been made heavier by water. The waters therefore mingled with the earth have attracted these herbs, belonging to the earth. The aetheris of the sun too on herbs are congested. If these herbs were burned would you not infer through the differences of all the weights how much earth over 100 lbs. you had acquired? It is manifest also that the extra weight had been added by that water. Elements are partly converted into one another, as we find, when glass is placed upon snow: we discover that the air on the glass is condensed into water, like a fluid on the glass. So we find that certain water is turned into stones like water into ice, & there is a quality, for hardening and turning into stone, in certain springs, which turn things placed in them into stone.
So it is said that Hungarian water is found, which, on account of vitriol in it, turns iron into copper.

++

L. If anyone were to hang a quantity of wool on one

15 Indeed it is established by such capacities that waters are not simple elements but are made up of elements, & it would be most valuable to possess the weights of all these waters of various capacities, so that from the difference of their weight in air & oil, we might make a close inference of their capacities.

P. So also concerning earth.

L. Yes, also concerning earth: since one kind is fertile another sterile, & in one we find stones & minerals, which are not found in another. It would therefore be very useful to know the various weights of different earths in water, air & oil, for the purpose of enquiring into their separate natures – so also from the difference of the weights of wines, wax, oils, gums, alleiminum, squills, leeks, & all such weight. I think that the capacities they possess in different forms could in some way be found out.

P. These things could scarcely be written in a very large book.

L. Experimental science demands extensive treatises, for in proportion as there have been more numerous so much the more infallibly can the knowledge concerning experiments, which they bring to notice, be arrived at.

P. Perchance even the weight of air can sometimes be arrived at by acute conjectures.

L. If anyone were to hang a quantity of wool dry & scorched on one

6 side of a large scale, and on the other side stones up to the same level, in a district & atmosphere of mild temperature, he would find that, as the air became moist, the weight of the wool would increase, & that as the air inclined to dryness, it would shrink. So by means of such variation he weighs the air & might make similar inferences concerning the changes of seasons. So should anyone wish to find out the varying strength of the sun in different climates, if from the more fertile fields of one as of the other climate he weighed a thousand grains of wheat or barley, from the difference of their weights he would find the varying strength of the sun; for, with a definite quantity & a field of equal fertility in any place you like, there could be no difference, save by reason of the sun. Thus indeed from the difference he would be able to seek after the strength of the sun in a region of mountains & of valleys, on the same ~~line~~ line, East & West.

P. If anyone let fall a stone from a high tower, while water was flowing from a rigid opening into a basin, meanwhile weighing this water that flowed forth; & likewise did the same ~~which~~ while a piece of wood of the same size was falling, could he not discover the weight of the air from the difference of the weights of the water relating to the wood & to the stone?

L. If anyone did this from different towers of equal height at different times he might at length reach an inference. Still he would discover the weight of the air quicker through different forms of equal weight.
For instance, if I let fall a pound of lead in spherical form from a turret, & gathered up the water from the clock, & then let out a pound of similar lead

17. of a broad shape, similarly gathering up the water, from the difference of the weights of the waters, the weight of the air would be found out. For we find that birds with wings spread out remain steadier, because they take up more air. So also in water a compact weight of spherical form sinks quicker than when extended into a square, & so by such a method the weight of air, & of water too, can be discovered, & conversely the different value of forms.

P. I have heard that the depth of the sea is sought by some such method.

L. It might be done with lead made into the image of an eight-day moon, with one horn heavier & the other lighter, & upon the lighter should be hung a fruit or other light thing of similar nature; & after the lead had dragged the fruit to the bottom, & first touching the earth with its heavier horn & then bending over, the fruit having been released from the horn would return to the surface. Knowledge would be obtained by using a similar lead & fruit in other waters of known depth: for from the different weights of water flowing out of a clock from the time the lead was cast forth to the return of the fruit (to the surface) in different waters the question is answered.

P. I believe that in such & other ways the depths of waters can be investigated. But tell me whether the speed of a ship's movement can thus be ascertained?

18 L. As how?

P. Why by throwing a fruit into the water from the bow, & letting water flow from a clock until the fruit has reached the stern, & then comparing the weights of the water at one & the other time.

L. Certainly by that or another method, as though the shooting forth & arrival of the ship, like an arrow quicker or slower as compared with the water from the clock.

P. The knowledge of the power of works & engines seems able to be investigated relatively, through the flow of water from a clock from the moment when an arrow is shot diametrically upwards till it returns to earth, so long as the different engines have arrows of the same size.

L. The power of bombarding engines certainly & of winds: so also of the rapid movements of men & animals, & of their strength & anything similar that can be mentioned could be investigated by inference from experiments with scales & by the flow of water from a clock.

P. How can the power of a man be found out?

L. You will see what weight, placed on one pan, a man can raise to a level with the empty pan by dragging down the latter. Then subtract the weight of this man from the weight he has pulled up, & what remains of the heaviness of that article, is proportionate to the power of the man.

19

P. So also the breath of a man can be weighed.

L. There is one weight of a man drawing in & holding his breath and another of his breathing out: also one of a living man & another of a dead one; so also among all animals. Whence it is admirable to have registered their difference among diverse animals & diverse men & among men of diverse age, so that inference may be able to reach up to the weight of living breaths.

P. Cannot the heat & cold & drought & moisture of a season be sought by such a method?

L. Certainly it can. For if you have marked the weight of water in a cold season, before it has frozen & afterwards, you will find it different. For when you see ice on the top of the water, you will notice that it is lighter than the water. So according to the intensity of the cold the variation of its weight increases. So also, if in a hot season you have exposed water to air, the weight will vary according to the ~~time~~ season. Or again, if you have weighed green wood, after some time you will ~~find~~ have found its weight altered, & will realize from this the excess of heat & cold, as also of dampness & drought.

P. Cannot also the time of day be thus weighed?

L. If you have taken the water flowing from a clock from sunset to sunrise & have weighed it, & again have made it flow on another day from sunrise, by comparing this weight of the water which has flowed out, with the first weight, you will be able to learn the hour & time of day.

20

P. Perhaps also the time of year?

L. Yes. if throughout the year from sunrise to sunset by means of the clock you have noted all the days, you will always be able to arrive inferentially both at the day of the month & the hour of the day; although on those days which have little variation in their brevity, you will do it less surely than at other times.

P. I perceive that by such a system the motion of celestial bodies can be arrived at, as Nemroth is said to have done & Hesparthus to have described.

L. You say right & it is granted that their work was done with assiduity & careful consideration. For if anyone, when he had noted a star set on the Meridional line, gathered the water flowing from a clock, until the star returned: & did likewise in respect of the sun from sunrise to sunrise, he would discover the movement of the sun towards the East from the difference of the lesser weight of the water belonging to the movement of the star from the Meridian line till its return to the same: also the sun's movement from rise to rise. For in proportion as the movement were less, so would its weight compare with the weight of the entire circle.

The movement would be in connection with the equinoctial circle, not the zodiac, which is not marked over the poles of the earth, but its own.

U. So if anyone wished to find out by means of this same star how far the sun had moved in 15 days, he could do it by this very method, from the varying distance of the sun's rise as compared with the situation of the star on the Meridian line.

For instance if to-day the difference of the position of the star on the line from the rising of the sun was found by the clock to be in a certain proportion to the weight of the water of the entire revolution of the star, then in 15 days another proportion would be found, owing to the difference of the movement — & always in connection with the Equinox.

P. Cannot motion in the Zodiac be found in this way?

L. It can certainly from the movement of the sun from mid-day to mid-day & from rise to rise, & from rising to setting. For by these differences the declination of the Zodiac from the Equinoctial line can be traced.

P. What about the difference of motion, which is said to take place from the Eccentric Circle?

L. This also will be found, when during the year dissimilarity is found in the Zodiac on similar days.
For the sun does not move from the Equinox in an equal number of days during the summer: it returns to the equinox first as in winter, when it does so quicker.

22. For it will not be found to have travelled from the "Scales" to the "Ram" in just so many days as from the "Ram" to the "Scales". This difference would disclose the eccentric or small orbit of the different movement.

P. What about the size of the sun's body?

L. By the weight of the water that flows from a clock, from the beginning of the sun's rising (in the equinoctial line), till it is entirely over the horizon, as compared with the water of the star's revolution, the appearance of the size of the sun's mass is known in relation to its sphere.
Nevertheless its size can be sought after by another method — namely solar eclipses.

P. How?

L. We find the moon's ~~motion~~ movement, in the same way as the sun's. Then from its eclipse + movement through the shadow of the earth we seek the size of the moon, in line with the pickle shadow of the earth: + from these we infer ~~the~~ its average proportion to be of a certain size in comparison with the earth.
Then from the movement of the moon + the eclipse of the sun, we seek the distance of the sun from the earth + its size by an acute calculation — though still by inference.

P. From these instances, which you have related, it seems that all differences of movements and

23. eclipses of luminary bodies; indeed the advances, halts, retrogressions, movements in straight lines, movements away from the centre, of all planets, can be arrived at from the same & unparalleled system of the scale & clock.

L. Yes, indeed you can, if you are sufficiently accurate in picking up the variations.

P. But what about the evidence of stars?

L. I think that also from the difference of the weights of water in one & another year, & by certain other differences of the weights of trees, herbs, & grains of corn, coming fertility or decay can be more quickly inferred from past experiments than from the movement of stars. For if in March the weight of water, air & trees be found to be of a certain degree, fertility of the earth ensues: if otherwise barreness or mean harvest. So also of wars, plague & all similar ordering events. And this is the root of the matter when from these ~~[illegible]~~ stars in succession we seek the evidence of stars, just as people seek the age of the moon from signs of the marrow in animals, fishes & crabs, from trees also & rushes, and ~~the zone of the sea from its flow~~ its zone from the flow of the sea.

P. I have heard that from the flow & ebb of the Nile the Egyptians foresee what is going to happen during the year.

L. Yes. There is no country which if it directed attention to such investigations would not make discoveries; & in accordance with this system, from the failures of fishes & reptiles at the beginning of winter, we anticipate extreme & lengthy cold, against which keen-scented nature has made provision for the animals.

P. What of the questions asked by astrologers? Can a favourable reply be made to them all by your system?

L. Well, if not favourable, at all events some reply, I think, can be made. But by what method an inference can be drawn in respect to these questions needs considerable investigation. Nor can the appropriate method be ascribed to scales, for he who is replying may perchance not be able to ascertain the weight of his reply, except from the weight of the question. And indeed the ardour for asking a question for the purpose of investigating some foresight of a future event seems to be misplaced. Possibly it does not appear whence the desire comes, just as if a man who feels something in his eye, which he does not see, looks for it from another point in order to see what is not there.

P. I think you indicate you would like replies to be sought for just as in the wheel of Pythagoras the method is handed down from the varying combination of the name of the mother asking the hour of the day & the light of the moon; or that one should sum up his inference; as seers do from oracular responses, or

25. by chance readings of books of the Sibyls, or from a stringed instrument, or houses, or geometrical figures, or the twitterings of birds, or the twirling flame of fire, or from reference to a third person, or some other casual intervention.

L. There have been people who used indirectly to seek for an answer out of a conversation which they were having with their questioner regarding new dispositions in the order of a country, as though a sudden opinion would make itself known in lengthy discussions. For if their conversation inclined to sadness, so it was thought would be the issue of the matter: but if towards joy, joyful would be the result. But I, having regard to the face, beard, movement of the eyes, style of words & the prophecy of the weights of the subjects, which I make my questioners tell me in repeated forms, used to consider that by giving such attention opinions can be formed. Still they are worth more when they come from a man, who lights upon truth without previous consideration; in whom a certain foreseeing spirit seems to speak. Nevertheless I think it is not possible to make a trade of such a matter, nor can a man who has discernment communicate it, nor should a wise man have leisure for these things.

P.

You speak excellently, for St. Augustine relates that there was a bibulous man in his time, to whom the thoughts of minds lay open, & who used to detect thieves & brought other secrets to view. Though

26 strange to say he was most unstable & had very little sense.

L. I know I myself have often related many things as the spirit gave me utterance & was almost ignorant of their reason. At length it appeared to me that a serious man ought not to speak without cause, & I became more silent.

P. Well after that it seems sufficient has been said concerning the movements of stars: something must now be added about music.

L. Yes, in respect of music experiments by scale are most useful. For from the difference of the weights of two brass bells, sounding a tone together, it is known in what relation of harmony the tone consists. So also concerning the weight of shepherds' pipes, & the proportion of the amounts of water filling the pipes is known — viz: Octave - 5 notes, 4 notes, & of all harmonies that can be made at all. So also from the weight of hammers, whose fall upon the ~~anv~~ anvil causes harmony of same description, and of drops falling from a rock into a pool, making various notes, and of flutes, & of all musical instruments, a system of considerable value is obtained by the scale.

P. So too of voices and songs.

L. Yes, in general all concordant harmonies are ~~traced~~ traced out more accurately by weights. Indeed the weight of ~~a thing~~ an instrument is ~~characteristic of~~ peculiar to its harmony, a relation

27. sprung from the varying combination of different things – Yes – friendships & enmities of animals & men of the same figure & manners and whatever of such a kind is weighed with regard to its concordant harmonies & contrary discords. So too the health of man is weighed as harmony, also his weakness – yea fickleness & seriousness, prudence & simplicity & many such things, if attention is minutely directed towards them.

P. What do you think concerning Geometry?

L. I think the close proportions of circles & squares, & all others which concern the different capacities of figures, can be tested more appropriately through weights than any other way. For supposing you have made a pillar-shaped vessel of known diameter and height, together with another cubic one of the same diameter & height, & have filled each with water & weighed them; their proportion will be known to you from the difference of the weights of the square in comparison with the circle to which it is assigned, and by this means a near inference can be formed of the circle squared, & whatever else concerning this matter that you desire to know. So, if you have taken two ~~[illegible]~~ wholly equal plates & have bent one into a circle to make a columnar vessel, & the other into a square for setting up a cubic vessel, & have filled these vessels with water, you will learn from the difference of their weights, the difference of the capacity of

"Fabriani" in original, meaning (dated at) Fabriano.
Probably the town in the Marches, Central Italy.

28 a circle & of a square of the same periphery. Thus if you have a number of such plates you will be able to form them into a triangle, a pentagon, a hexagon, & so investigate successively their various capacities. In like manner by weight you will be able to arrive at the knowledge of the capacities of vessels of any shape whatever, & how scales may be made as instruments for measuring & weighing, how one pound lifts up 1000 lbs. owing to its distance from the pivot & its varying way of descent, whether straighter or more curling, & how all the fine lines of ships & machines ought to be made. Whence I consider that this knowledge gained by experience of weights is most useful for all geometrical arts.

P. Now you have sufficiently explained the appropriate reasons for weights of things being taken on a balance, & registered one after another & over & over again. For it seems a book like that would be most useful & sought after among distinguished men, so that in different regions its contents may be authenticated & unified: that we may be led more easily to the knowledge of many things hitherto concealed from us. I certainly will not delay from hastening it in every respect.

L. If you love me, be diligent – farewell – Thanks be to God.

The book of the layman concerning experiments with weights is finished, ~~on the day of Fabriano~~ 13th September.

FABRIANO,

Nicholas, Cardinal of St. Peter.

W.W.F.

30.viii.19.

29 (wbt)